Patent claims

1. Process for preparing optically pure PPI having a sulphinyl structure in enantiomerically pure or enantiomerically enriched form by oxidation of the corresponding sulphides, characterized in that the oxidation is carried out in the presence of a chiral zirconium complex or a chiral hafnium complex.

2. Process for preparing optically pure PPI having a sulphinyl structure in enantiomerically pure or enantiomerically enriched form by oxidation of the corresponding sulphides, characterized in that the oxidation is carried out in the presence of a chiral zirconium complex.

3. Process according to Claim 1, characterized in that the optically pure PPI having a sulphinyl structure is obtained in an optical purity of > 90%.

4. Process according to Claim 1, characterized in that the oxidation is carried out using cumene hydroperoxide.

5. Process according to Claim 1, characterized in that zirconium(IV) acetylacetonate, zirconium(IV) butoxide, zirconium(IV) tert-butoxide, zirconium(IV) ethoxide, zirconium(IV) n-propoxide, zirconium(IV) isopropoxide or zirconium(IV) isopropoxide/isopropanol complex or hafnium(IV) acetylacetonate, hafnium(IV) butoxide, hafnium(IV) tert-butoxide, hafnium(IV) ethoxide, hafnium(IV) n-propoxide, hafnium(IV) isopropoxide or hafnium(IV) isopropoxide/isopropanol complex is used.

6. Process according to Claim 2, characterized in that zirconium(IV) acetylacetonate, zirconium(IV) butoxide, zirconium(IV) tert-butoxide, zirconium(IV) ethoxide, zirconium(IV) n-propoxide, zirconium(IV) isopropoxide or zirconium(IV) isopropoxide/isopropanol complex is used.

7. Process according to Claim 1, characterized in that the chiral auxiliary used is a chiral tartaric acid derivative.

8. Process according to Claim 1, characterized in that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-diallylamide), (+)-L-tartaric acid bis-(N,N-dibenzylamide), (+)-L-tartaric acid bis-(N,N-diisopropylamide), (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide), (+)-L-tartaric acid bis-(N-piperidinamide), (+)-L-tartaric acid bis-(N-morpholinamide), (+)-L-tartaric acid bis-(N-cycloheptylamide), (+)-L-tartaric acid bis-(N-4-methyl-N-piperazinamide), dibutyl (+)-L-tartrate, di-tert-butyl (+)-L-tartrate, diisopropyl (+)-L-tartrate, dimethyl (+)-L-tartrate, diethyl (+)-L-tartrate, (-)-D-tartaric acid bis-(N,N-diallylamide), (-)-D-tartaric acid bis-(N,N-dibenzylamide), (-)-D-tartaric acid bis-(N,N-diisopropylamide), (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide, (-)-D-tartaric acid bis-(N-piperidinamide), (-)-D-tartaric acid bis-(N-morpholinamide), (-)-D-tartaric acid bis-(N-cycloheptylamide), (-)-D-tartaric acid bis-(N-4-methyl-N-

piperazinamide), dibutyl (-)-D-tartrate, di-tert-butyl (-)-D-tartrate, diisopropyl (-)-D-tartrate, dimethyl (-)-D-tartrate or diethyl (-)-D-tartrate.

9. Process according to Claim 1, characterized in that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide), (+)-L-tartaric acid bis-(N-morpholinamide), (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide) or (-)-D-tartaric acid bis-(N-morpholinamide).

10. Process according to Claim 1, characterized in that the oxidation is carried out in the presence of an organic base.

11. Process according to Claim 1, characterized in that the oxidation is carried out in the presence of a tertiary amine.

12. Process according to Claim 1, characterized in that the oxidation is carried out in organic solvents.

13. Process according to Claim 1, characterized in that the oxidation is carried out in organic solvents comprising 0 to 0.3% by volume of water.

14. Process according to Claim 1, characterized in that the oxidation is carried out in an organic solvent which essentially comprises methyl isobutyl ketone.

15. Process according to Claim 1, characterized in that the zirconium component used is zirconium(IV) acetylacetonate, zirconium(IV) butoxide, zirconium(IV) tert-butoxide, zirconium(IV) ethoxide, zirconium(IV) n-propoxide, zirconium(IV) isopropoxide, or zirconium(IV) isopropoxide/isopropanol complex, and that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-diallylamide), (+)-L-tartaric acid bis-(N,N-dibenzylamide), (+)-L-tartaric acid bis-(N,N-diisopropylamide), (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide), (+)-L-tartaric acid bis-(N-piperidinamide), (+)-L-tartaric acid bis-(N-morpholinamide), (+)-L-tartaric acid bis-(N-cycloheptylamide), (+)-L-tartaric acid bis-(N-4-methyl-N-piperazinamide), dibutyl (+)-L-tartrate, di-tert-butyl (+)-L-tartrate, diisopropyl (+)-L-tartrate, dimethyl (+)-L-tartrate, diethyl (+)-L-tartrate, (-)-D-tartaric acid bis-(N,N-diallylamide), (-)-D-tartaric acid bis-(N,N-dibenzylamide), (-)-D-tartaric acid bis-(N,N-diisopropylamide), (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide), (-)-D-tartaric acid bis-(N-piperidinamide), (-)-D-tartaric acid bis-(N-morpholinamide), (-)-D-tartaric acid bis-(N-cycloheptylamide), (-)-D-tartaric acid bis-(N-4-methyl-N-piperazinamide), dibutyl (-)-D-tartrate, di-tert-butyl (-)-D-tartrate, diisopropyl (-)-D-tartrate, dimethyl (-)-D-tartrate or diethyl (-)-D-tartrate.

16. Process according to Claim 1, characterized in that the zirconium component used is zirconium(IV) acetylacetonate, zirconium(IV) butoxide, zirconium(IV) tert-butoxide, zirconium(IV) ethoxide, zirconium(IV) n-propoxide, zirconium(IV) isopropoxide, or zirconium(IV) isopropoxide/isopropanol complex, that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-diallylamide), (+)-L-tartaric acid bis-

(N,N-dibenzylamide), (+)-L-tartaric acid bis-(N,N-diisopropylamide), (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide), (+)-L-tartaric acid bis-(N-piperidinamide), (+)-L-tartaric acid bis-(N-morpholinamide), (+)-L-tartaric acid bis-(N-cycloheptylamide), (+)-L-tartaric acid bis-(N-4-methyl-N-piperazinamide), dibutyl (+)-L-tartrate, di-tert-butyl (+)-L-tartrate, diisopropyl (+)-L-tartrate, dimethyl (+)-L-tartrate, diethyl (+)-L-tartrate, (-)-D-tartaric acid bis-(N,N-diallylamide), (-)-D-tartaric acid bis-(N,N-dibenzylamide), (-)-D-tartaric acid bis-(N,N-diisopropylamide), (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide), (-)-D-tartaric acid bis-(N-piperidinamide), (-)-D-tartaric acid bis-(N-morpholinamide), (-)-D-tartaric acid bis-(N-cycloheptylamide), (-)-D-tartaric acid bis-(N-4-methyl-N-piperazinamide), dibutyl (-)-D-tartrate, di-tert-butyl (-)-D-tartrate, diisopropyl (-)-D-tartrate, dimethyl (-)-D-tartrate or diethyl (-)-D-tartrate and that the oxidation is carried out in the presence of an organic base.

17. Process according to Claim 1, characterized in that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide), (+)-L-tartaric acid bis-(N-morpholinamide, (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide) or (-)-D-tartaric acid bis-(N-morpholinamide) and that the oxidation is carried out in the presence of an organic base.

18. Process according to Claim 1, characterized in that (S)-5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (S)-5-difluoromethoxy-2-[(3,4-dimethoxy-2-pyridinyl)-methylsulphinyl]-1H-benzimidazole, (S)-2-[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridinyl)methyl-sulphinyl]-1H-benzimidazole, (S)-2-{[4-[3-methoxypropoxy)-3-methylpyridin-2-yl]methylsulphinyl}-1H-benzimidazole, (S)-5-methoxy-2-((4-methoxy-3,5-dimethyl-2-pyridylmethyl)sulphinyl/}-1H-imidazo-(4,5-b)pyridine, (R)-5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridinyl)methylsulphinyl]-1H-benz-imidazole, (R)-5-difluoromethoxy-2-[(3,4-dimethoxy-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (R)-2-[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (R)-2-{(4-(3-methoxypropoxy)-3-methylpyridin-2-yl)methylsulphinyl}-1H-benzimidazole or (R)-5-methoxy-2-((4-methoxy-3,5-dimethyl-2-pyridylmethyl)sulphinyl)-1H-imidazol(4,5-b)pyridine is prepared by the process.

19. Process according to Claim 1, characterized in that the chiral auxiliary used is (-)-D-tartaric acid bis-(N,N-dimethylamide), (-)-D-tartaric acid bis-(N-pyrrolidinamide) or (-)-D-tartaric acid bis-(N-morpholinamide) and that the process product prepared is (+)-pantoprazole.

20. Process according to Claim 1, characterized in that the zirconium component used is zirconium(IV) n-propoxide, zirconium(IV) isopropoxide or zirconium(IV) isopropoxide/isopropanol complex, that the chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide) or (+)-L-tartaric acid bis-(N-morpholinamide), that the oxidation is carried out using cumene hydroperoxide and that the process product prepared is (-)-pantoprazole.

21. Process according to Claim 1, characterized in that the zirconium component used is zirconium(IV) n-propoxide, zirconium(IV) isopropoxide or zirconium(IV) isopropoxide/isopropanol complex, that the

chiral auxiliary used is (+)-L-tartaric acid bis-(N,N-dimethylamide), (+)-L-tartaric acid bis-(N-pyrrolidinamide) or (+)-L-tartaric acid bis-(N-morpholinamide), that the oxidation is carried out using cumene hydroperoxide in the presence of a tertiary amine and that the process product prepared is (-)-pantoprazole.

22. (S)-5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (S)-5-difluoromethoxy-2-[(3,4-dimethoxy-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (S)-2-[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (S)-2-{[4-(3-methoxypropoxy)-3-methylpyridin-2-yl]methylsulphinyl}-1H-benzimidazole or (S)-5-methoxy-2-((4-methoxy-3,5-dimethyl-2-pyridylmethyl)sulphinyl)-1H-imidazo[4,5-b]pyridine, (R)-5-methoxy-2-[(4-methoxy-3,5-dimethyl-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (R)-5-difluoromethoxy-2-[(3,4-dimethoxy-2-pyridinyl)-methylsulphinyl]-1H-benzimidazole, (R)-2-[3-methyl-4-(2,2,2-trifluoroethoxy)-2-pyridinyl)methylsulphinyl]-1H-benzimidazole, (R)-2-{[4-(3-methoxypropoxy)-3-methylpyridin-2-yl]methyl-sulphinyl}-1H-benzimidazole or (R)-5-methoxy-2-((4-methoxy-3,5-dimethyl-2-pyridylmethyl)sulphinyl)-1H-imidazo[4,5-b]pyridine prepared by the process according to Claim 1.